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A View in the Sour-Cherry Pruning Block

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Effects of Pruning on the Growth and Yield of Cherry Trees

by H. L. CRANE†

ALTHOUGH long and widely grown in West Virginia, the cherry, both sweet and sour, has remained a fruit of minor importance in this state. In recent years considerable interest has been taken in the production of sour cherries for canning purposes in the Eastern Panhandle. Profitable production of fruit is determined very largely by the yields, and high yields are not consistently obtained without adequate growth of the trees. Since tree growth and yield are closely correlated, the growth and vigor of the trees must be maintained. For this purpose certain practices such as pruning must be employed. In order to study the relations of pruning to the growth and yield of cherry trees an experiment was undertaken in which varying degrees of dormant and summer pruning were used.

HISTORY AND PLAN OF EXPERIMENT

The cherry orchard used in this experiment is located on the Horticulture Farm of the Agricultural Experiment Station at Morgantown. The experiment consisted of seven rows of 30 trees each. Trees numbered one to 15 in each row were of the sour variety Montmorency, and trees 16 to 30 were of the sweet variety Schmidt. The orchard was planted in rows 16 feet wide and the trees 13 feet apart in the rows. One-year-old trees, carefully selected for uniformity of size and vigor, were planted in the spring of 1916. The root systems of the individual trees were pruned as nearly alike as practicable before planting, removing mainly the broken roots and cutting off the rough irregular ends. The tops of all trees were cut off 20 inches from the bud, and the trees were planted so that about two inches of the trunk above the bud was covered.

During the growing season of 1916 all the trees of the Schmidt variety made a satisfactory, uniform growth, but many of the Montmorency trees died, while the growth of the remaining trees was so irregular that all of the latter variety were pulled out and replanted during December. The growth of the replanted Montmorency trees was variable during the growing season of 1917. The following spring (1918) they were severely pruned, leaving only four laterals and a leader. These were cut back to two buds each in an effort to even up the growth. This practice was successful to the extent that

†Resigned November, 1929.

the pruning and training work with the Montmorency trees could begin in the spring of 1919. The pruning and training experiment with the Schmidt variety was started in the spring of 1917.

Eight pruning treatments were used on each variety, as follows:

(1) corrective dormant pruning (a light pruning)

(2) moderate dormant pruning

(3) heavy dormant pruning

(4) early summer pruning, of about the same severity as (2) but done from June 10 to 20

(5) moderate dormant pruning and early summer "pinching". The early summer treatment consisted of pinching back the tips of the laterals to induce branching

(6) light dormant pruning and repeated summer pinching. The repeated summer pinchings were given about the middle of June, middle of July, and first of August, with the idea of causing branching and, in the later pinching, cessation of growth and inducement of fruit-bud formation

(7) late summer pruning, of about the same severity as (2) but done the first to the middle of August

(8) moderate dormant pruning and late summer pinching. The late summer pinching was done in August. Only the growing points were removed in an attempt to check growth and stimulate fruit-bud formation

The early, late, and repeated summer pinching of the growing terminals was continued only during the first five years of the life of the trees. In succeeding years the trees in plots 5, 6, and 8 received only dormant pruning.

Each plot consisted of a single row of trees except in treatments 7 and 8. In these half-rows were used, that is, trees 1 to 8 and 16 to 23 received treatment 7, and trees 9 to 15 and 24 to 30 received treatment 8.

The trees in this experiment were all trained to the modified central leader system, eight scaffold branches being formed on each leader, which was then removed. In the first season three or four scaffold branches were selected in addition to the central leader. These were headed back lightly, moderately, or heavily, depending on severity of the pruning treatment. All other branches were removed. Pruning in the second season consisted in reducing the number of laterals on each main scaffold branch to two, all other shoots being removed. One or two more scaffold branches were left on the central leader, and all the shoots were cut back so as to make a difference in the severity of pruning. During the third and fourth seasons the other scaffold branches were formed. When they were eight in number, the central leader was removed.

The subsequent pruning was of the nature of thinning out the thick places in the trees and removal of interfering or crossing limbs. No heading was practiced after the fourth year except in the heavy dormant treatment (3), where the heading consisted of cutting back to outside laterals in branches that had grown beyond the general outline of the tree. Each year, after the general framework of the trees was formed, the trees were pruned so that a distinct difference in the thickness of the tree tops of the different plots was evident. The trees which received the early summer (4) and the late summer pruning (7) were pruned as nearly the same as the moderate dormant (2) as was possible. This was very difficult because the foliage present at the time of pruning obscured the branches and shoots.

A system of cultivation and cover crop was used each year until the spring of 1926. The cultivation consisted in shallow plowing in early spring, followed by rather frequent cultivations with a disc or light draft harrow until August, when a cover crop consisting of a mixture of rye and hairy vetch was seeded broadcast. At the time of seeding the cover crop, an application was made of about 300 pounds per acre of 16% superphosphate. No nitrogen-carrying fertilizer was applied to the trees until the spring of 1925, at about the time of blooming, when four pounds of nitrate of soda was applied to each tree. In the spring of 1926 and thereafter the nitrate application was increased to five pounds per tree and was applied at or just before the time of flowering. In the spring of 1926, because of soil erosion and the serious injury to the tree trunks and crotches from low winter temperatures, the orchard was put in sod. Since 1926 the grass has been cut twice each season and allowed to lie where it fell. In the spring of 1928 the sod was top-dressed with 400 pounds of 16% superphosphate per acre. The trees were given the regular spray schedule for cherries. By the spring of 1921 the Schmidt trees had been so severely winter-injured that this part of the experiment was discontinued, and the trees were pulled out.

METHODS USED IN TAKING DATA

Immediately after planting, the circumference of the tree trunks was measured at a point midway between the surface of the soil and the point where the head of the trees was to be formed. This point was marked by painting with white lead and oil a narrow band halfway around the trees. Each spring, with the exception of 1918, the circumference of the tree trunks was measured at this point.

In order to determine the effect of pruning on tree growth the total length of the new shoots produced during the previous growing season was measured in the early spring. The total length of the new shoots produced on each tree was measured in the case of the variety Montmorency for the 5-year period 1917 to 1921, and for the Schmidt for the 5-year period 1916 to 1920. After the new growth was measured the trees were pruned, and the total lengths of the shoots removed were taken. After 1921 the weight of all the wood removed in pruning was used as an index of the severity of the pruning.

TABLE 1.—*Influence of pruning on total length of shoot growth produced per tree during the first five years after planting*

Varieties	Pruning treatment	Total lengths of shoot-growth in feet produced by seasons						Five-year total
		1916	1917	1918	1919	1920	1921	
SCHMIDT	1. Corrective dormant	3.5	17.0	43.8	151.6	165.0		380.9
	2. Moderate dormant	3.6	18.1	44.7	149.1	178.6		394.1
	3. Heavy dormant	2.7	14.2	36.9	118.0	140.3		312.1
	4. Early summer	3.3	16.7	40.0	123.6	130.2		312.8
	5. Moderate dormant and early summer pinching	3.0	21.5	32.0	103.8	121.4		281.7
	6. Light dormant and repeated summer pinching	2.5	13.3	37.2	110.8	123.0		286.8
	7. Late summer	3.9	5.7	31.3	112.6	104.2		257.7
	8. Moderate dormant and late summer pinching	4.2	13.0	34.2	112.0	113.8		277.2
MONTMORENCY	1. Corrective dormant		6.1	31.6	133.9	299.7	775.4	1246.7
	2. Moderate dormant		5.8	28.0	110.1	222.5	516.6	883.0
	3. Heavy dormant		5.9	24.6	105.5	214.4	558.0	908.4
	4. Early summer		6.0	14.9	103.3	186.5	328.7	639.4
	5. Moderate dormant and early summer pinching		8.7	27.0	115.8	211.0	446.2	808.7
	6. Light dormant and repeated summer pinching		9.7	27.0	118.7	187.1	453.0	795.5
	7. Late summer		5.3	31.5	127.5	131.5	498.8	794.6
	8. Moderate dormant and late summer pinching		3.0	19.0	77.2	154.1	451.9	705.2

To obtain a record of the fruiting of the trees, the amount of bloom was estimated for three years in the case of the variety Montmorency. This was discontinued because of winter injury to the buds. The yield of fruit was measured in total number of quarts per tree.

PRESENTATION OF DATA

The data dealing with the effects of the various pruning treatments on the growth of the trees will be considered first, after which the influence of these treatments on the yield of fruit will be presented. In some instances the significance of the data has been determined by Student's method as advocated by Love and Brunson *(5)*. In the tables where this method of calculation has been used the column dealing with odds is important as it gives a fairly accurate measure of the significance of a difference between treatments. Odds greater than 30:1 approach absolute certainty as a limit, while odds much smaller than 30:1 indicate tendencies only.

Tree Growth

The data presented in this report cover tree growth as influenced by various pruning treatments during the first five years of the life of the variety Schmidt and during the first 12 years of the variety Montmorency. The data dealing with the growth are divided into two parts: (a) annual shoot growth, and (b) increase in trunk diameter.

Annual Shoot Growth

The total length of all new shoots formed each year was measured to determine the influence of the various pruning treatments on the growth of the trees. These data are given in Table 1. The Montmorency trees of plot 1, subjected to corrective dormant pruning, made much greater growth than the more severely dormant or summer-pruned trees. The Schmidt trees which were correctively pruned made slightly less total growth during the 5-year period than the trees which were pruned moderately during the dormant season (plot 2); but they made considerably more growth than the trees of the other treatments. The correctively pruned Montmorency trees made more total new growth during the 5-year period than any of the others. These differences first were noticeable in the second year of the experiment.

One of the striking facts brought out by the data of Table 1 is the marked reduction in the growth of the Montmorency trees which were pruned in early summer as compared to those correctively dormant-pruned. This pruning was done in June; consequently many leaves, formed largely at the expense of the food stored the previous year, were removed before they had contributed to the food reserves of the trees. Late summer pruning, likewise, greatly reduced tree growth in both varieties.

Summer pinching of the shoots, regardless of whether it was done in early or late summer or was repeated during the summer, reduced the growth of the trees. This practice seemed to be of little or no aid in forming the framework or in controlling the growth of the trees. The new shoots formed on the correctively pruned trees were more numerous but not as long or stocky as those on the more severely pruned trees. In general the correctively pruned trees had, during and at the end of the first five years after planting, the most symmetrical, compact, and well-formed heads of all the trees under experiment.

TABLE 2.—*Influence of pruning treatment on the average total shoot growth produced by cherry trees**

Varieties	Year	Average total shoot growth — Pruning treatment numbers 1	2	3	4	5	6	7	8
SCHMIDT	1916	1.00	1.03	.77	.94	.88	.71	1.11	1.20
	1917	1.00	1.06	.83	.98	1.26	.78	.34	.76
	1918	1.00	1.02	.84	.91	.73	.85	.71	.78
	1919	1.00	.98	.77	.82	.68	.73	.74	.74
	1920	1.00	1.08	.85	.79	.74	.75	.63	.69
	Average	1.00	1.06	.81	.89	.85	.76	.71	.83
	Odds		—16:1	4600:1	54:1	7:1	3060:1	25:1	13:1
MONTMORENCY	1917	1.00	.95	.97	.98	1.43	1.59	.87	.49
	1918	1.00	.89	.78	.47	.85	.85	1.00	.60
	1919	1.00	.82	.79	.77	.86	.89	.95	.58
	1920	1.00	.74	.72	.62	.70	.62	.44	.51
	1921	1.00	.67	.72	.42	.58	.58	.64	.58
	Average	1.00	.81	.79	.65	.88	.91	.78	.55
	Odds		94:1	174:1	72:1	3:1	2:1	18:1	>4999:1

*In this table the average annual length of new growth produced on the trees of treatment 1 (corrective dormant) has been taken as unity, and the growth of the trees of the other treatments has been compared with it.

As a measure of the significance of the differences in total length of new shoots formed by the trees in the pruning treatments, the data of Table 1 have been used in the calculation of odds by employing Student's method. In these calculations the annual growth of the trees of the different treatments has been compared to treatment 1 (corrective dormant), which, with one exception, has produced the most growth. This exception is in the case of treatment 2, of the Schmidt variety which had been moderately dormant pruned. Here the odds indicate that these trees made slightly more growth than those which received the corrective pruning. In all other cases the odds indicate that the correctively pruned trees made the most growth. These data are given in Table 2. The wide difference between the growth of the Montmorency trees of treatments 1 and 8 was not due entirely to the pruning but in part to poorer soil. Heavy dormant, moderate dormant, and early summer pruning significantly reduced the growth of the trees as compared to those correctively dormant-pruned. The differences between the other treatments are as a rule not mathematically significant and indicate tendencies only.

It is now well known that pruning young trees reduces their size and growth somewhat in proportion to the severity of the pruning. As an index of the severity of the pruning given the trees two measurements have been used: (a) the length of new wood removed, and (b) the weight of the wood cut off.

Length of Wood Removed. The trees were all trained to the same form with a definite number (8) of main scaffold branches on each tree. For this reason the early pruning of the trees, particularly with the lightly and correctively pruned ones, was more severe in their early life than later, so that at the beginning of this experiment, and until the frameworks of the trees were formed, this type of training had a tendency to give the trees under the various treatments the same start. It was thus possible only during the last two years that measurements of the length of new wood removed in pruning were taken to bring about a distinct difference in the severity of pruning. In the case of the variety Schmidt this was not found possible to the same exent as with the variety Montmorency.

FIG. 1.—Schmidt cherry trees affected by winter injury

The average and total lengths of wood removed per tree during four of the five years are given in Table 3. These data show that with the variety Montmorency a wide difference was effected in the severity of the pruning applied to the trees in the various treatments. The heavily pruned trees (3) had about 60 percent of the wood removed in pruning; the corrective dormant (1) about half as much, or 30 percent. The moderately dormant pruned trees, or plots 2, 5, and 8, pere pruned intermediate in severity between corrective dormant (1) and heavy dormant (3). Such clear-cut differences could not be made with the sweet cherries because of the nature of their growth and the injury following the winter of 1918-1919.

TABLE 3.—*Wood removed in pruning experiments with cherry trees*

Varieties	Pruning treatment	Average length of wood removed in feet per tree by years 1917	1918	1919	1920	1921	Total	Total shoot growth 1917-1920	Percentage of growth removed 1917-1920
SCHMIDT	1. Corrective dormant	7.6	15.6	76.8	73.0		173.0	377.4	45.84
	2. Moderate dormant	10.3	20.6	99.5	85.5		215.9	390.5	55.29
	3. Heavy dormant	7.5	20.6	82.9	76.2		187.2	309.4	60.50
	4. Early summer	5.7	22.5	75.3	70.9		174.4	309.5	56.35
	5. Moderate dormant and early summer pinching	13.2	12.8	68.5	58.3		152.8	278.7	54.82
	6. Light dormant and repeated summer pinching	4.1	12.8	61.2	67.7		145.8	284.3	51.28
	7. Late summer	3.1	18.6	78.3	64.7		164.7	253.8	64.89
	8. Moderate dormant and late summer pinching	6.9	19.2	68.0	64.1		158.2	273.0	57.95
MONTMORENCY	1. Corrective dormant		23.3	61.8	106.1	205.9	397.1	1240.6	32.01
	2. Moderate dormant		20.4	71.2	105.0	246.1	442.7	877.2	50.47
	3. Heavy dormant		19.6	80.6	121.5	344.6	566.3	902.5	62.75
	4. Early summer		17.9	84.8	109.5	125.0	337.2	633.4	53.24
	5. Moderate dormant and early summer pinching		19.9	75.8	90.0	237.6	423.3	800.0	52.91
	6. Light dormant and repeated summer pinching		17.8	62.8	52.4	172.7	305.7	785.8	38.90
	7. Late summer		18.4	71.5	90.8	255.6	436.3	789.3	55.28
	8. Moderate dormant and late summer pinching		13.3	49.4	78.4	196.3	337.4	702.2	48.05

TABLE 4.—*Average and total weight of wood removed per tree in pruning Montmorency cherry trees*

Treatment	Average weight in pounds of wood removed by years 1921	1922	1923	1924	1925	1926	1927	1928	1929	Total for nine years	Average per year
1. Corrective dormant	1.39	4.03	4.36	5.27	6.95	3.96	5.03	5.24	9.71	45.94	5.10
2. Moderate dormant	1.63	5.22	5.84	4.32	6.37	5.78	4.21	3.30	13.94	50.61	5.62
3. Heavy dormant	2.17	5.94	8.74	6.45	6.75	6.84	6.77	7.90	14.50	66.06	7.34
4. Early summer	1.16	1.81	3.36	3.01	2.55	3.51	5.57	6.01	....	*26.98	3.37
5. Moderate dormant and early summer pinching	1.40	4.30	4.81	4.01	4.64	3.16	5.33	6.83	12.73	47.21	5.25
6. Light dormant and repeated summer pinching	.72	2.96	2.72	2.21	2.96	1.57	2.73	1.64	5.22	22.73	2.53
7. Late summer	2.98	3.11	2.72	1.73	2.66	4.70	3.22	5.00	....	*26.12	3.26
8. Moderate dormant and late summer pinching	2.28	3.51	3.14	3.50	2.82	1.45	2.47	2.03	7.25	28.45	3.16

*Only eight years included as the trees were not pruned in the summer of 1929.

Weight of Wood Removed. After the measurements of the length of wood removed by pruning were discontinued, the trees were pruned so that a difference in thickness or compactnees of the trees under the various treatments existed irrespective of the amount of wood removed. The wood cut from the trees was weighed as indicated in Table 4. Data are included only for the Montmorency, as the Schmidt trees were all removed in the spring of 1921 because of winter injury. (See Fig. 1.) These data show that on the average less wood was removed from the early or late summer-pruned trees (treatments 4 and 7) than from those of the other treatments, with two exceptions: (1) trees of treatment 6 received a light dormant pruning and repeated summer pinching the first five years and light dormant pruning in succeeding years; and (2) trees of treatment 8 received moderate dormant pruning and late summer pinching the first five years. Less wood was removed from the summer-pruned trees because this pruning reduced the growth and severely dwarfed the trees. The continued heavy and moderate dormant pruning also had reduced the size of the trees to such an extent that in some years as much or more wood was removed from the correctively dormant pruned trees. In general, slightly more wood was removed from the moderately dormant pruned trees than from the correctively pruned ones, and much more was removed from the heavily pruned trees.

Diameter of Tree Trunks

Probably the best index of the growth of trees as influenced by certain practices is the year-by-year gain in trunk girth. For this reason the circumference of tree trunks was measured each year during the dormant season at a definite point. From these figures diameter data were calculated in the usual way (Table 5.). Data for the average diameter of the tree trunks at the time of planting are also included. These show that the trees were uniform in size at that time. Even though the difference in severity of pruning of the young trees was not marked, the correctively pruned trees soon developed the largest trunks. The correctively pruned trees of both varieties had the largest trunks by the end of the second year after planting, while the size of the trunks of the other plots failed to increase as rapidly. Summer pruning done in either early or late summer caused the size of the tree trunks to be smaller than a pruning of about the same severity done in the dormant season. The evidence is fairly conclusive that summer pruning is more dwarfing in its effects on the trunks than a similar treatment made during the dormant season. Summer pinching-back of the terminals, even though a small amount of wood and leaves was removed, reduced the growth of the trunks in all instances but one. The responses of both sweet and sour cherries to the varying degrees of dormant and summer pruning and pinchings were very similar. The data show that the largest trunks were secured with young trees by very light dormant pruning.

TABLE 5.—*Comparison of the average trunk diameters of cherry trees pruned in various ways recorded by varieties, treatments, and years*

Varieties	Treatment	Trunk diameters in inches by years													
		*1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
SCHMIDT	1. Corrective dormant	.45	.61	1.09	1.75	2.56	3.52	Trees removed							
	2. Moderate dormant	.44	.57	1.05	1.72	2.46	3.22								
	3. Heavy dormant	.44	.57	.97	1.58	2.31	2.79								
	4. Early summer	.44	.60	1.00	1.56	2.07	2.51								
	5. Moderate dormant and early summer pinching	.43	.53	.93	1.50	2.25	2.67								
	6. Light dormant and repeated summer pinching	.43	.52	.99	1.63	2.24	2.65								
	7. Late summer	.46	.62	.96	1.55	2.19	2.48								
	8. Moderate dormant and late summer pinching	.43	.52	.89	1.51	2.23	2.61								
MONTMORENCY	1. Corrective dormant	.29	No records made		.93	1.74	2.55	3.51	4.24	4.73	5.13	5.50	6.09	6.67	7.38
	2. Moderate dormant	.28			.79	1.55	2.28	3.21	3.76	4.32	4.59	4.81	5.19	5.50	6.12
	3. Heavy dormant	.31			.88	1.53	2.23	3.10	3.68	4.30	4.60	4.94	5.38	5.77	6.04
	4. Early summer	.28			.78	1.19	1.73	2.47	2.99	3.45	3.72	3.90	4.46	5.13	5.78
	5. Moderate dormant and early summer pinching	.29			.86	1.49	2.19	3.02	3.57	4.03	4.41	4.58	5.18	5.82	6.55
	6. Light dormant and repeated summer pinching	.30			.91	1.52	2.19	2.97	3.53	4.01	4.16	4.31	4.80	5.14	5.65
	7. Late summer	.30			.85	1.47	2.04	284	3.24	3.68	3.89	4.02	4.49	4.84	5.35
	8. Moderate dormant and late summer pinching	.26			.70	1.34	1.92	2.66	3.13	3.50	3.60	3.71	4.16	4.51	5.01

*Diameter of the tree trunks at the time of planting. The Schmidt trees were planted in April, 1916, and the Montmorency in December, 1916.

In order to show more clearly the relation of various types of pruning to the growth of the tree trunks, the average annual increase in diameter has been calculated according to Student's method as given in Table 6. In every case the trunks of trees pruned more severely than those correctively pruned were smaller and, in general, made a smaller annual gain in diameter than those of the lightly pruned trees. These differences are supported by highly significant odds in every one of the Montmorency plots and in three of the Schmidt. Early or late summer pruning of the trees of both varieties reduced the gain in trunk diameter. The data indicate that late summer pruning reduces the growth of the trunks slightly more than a corresponding pruning given in early summer. However, the difference between the early and late summer-pruned trees may be due to the location of the latter on slightly poorer soil. Pinching-back of the terminals before growth ceased, even though only small amounts of wood and leaves were removed, appreciably reduced the amount of gain in diameter of the trunks.

The effect of fruit production on trunk diameter of the variety Montmorency should be pointed out. From the data in Table 6 it will be seen that the annual gain in diameter of the trunks was much smaller during the growing seasons of 1923, 1924, and 1925 than before or after this period. An inspection of the data of Table 8 shows that the crop of 1923 was the first one produced. The two following

TABLE 6.—*Influence of pruning practices on the average annual increase in trunk diameter (inches) of cherry trees*

Varieties	Year	Increase in trunk diameter in inches							
		Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8
SCHMIDT	1916	.16	.13	.13	.16	.10	.09	.16	.09
	1917	.48	.48	.40	.40	.40	.47	.34	.37
	1918	.66	.67	.61	.56	.57	.64	.59	.62
	1919	.81	.74	.73	.51	.75	.61	.64	.72
	1920*	.96	.76	.48	.44	.42	.41	.29	.38
	Σ	3.07	2.78	2.35	2.07	2.24	2.22	2.02	2.18
	Average	.614	.556	.470	.414	.448	.444	.404	.436
	Odds		7:1	144:1	12:1	177:1	10:1	22:1	161:1
MONTMORENCY	1918**	.64	.51	.57	.50	.57	.61	.55	.44
	1919	.81	.76	.65	.41	.63	.61	.62	.64
	1920	.81	.73	.70	.54	.70	.67	.57	.58
	1921	.96	.93	.87	.74	.83	.78	.80	.74
	1922	.73	.55	.58	.52	.55	.56	.40	.47
	1923	.49	.56	.62	.46	.46	.48	.44	.37
	1924	.40	.27	.30	.27	.38	.15	.21	.10
	1925	.37	.22	.34	.18	.17	.15	.13	.11
	1926	.59	.38	.44	.56	.60	.49	.47	.45
	1927	.58	.31	.39	.67	.64	.34	.35	.35
	1928	.71	.62	.27	.65	.73	.51	.51	.50
	Σ	7.09	5.84	5.73	5.50	6.26	5.35	5.05	4.75
	Average	.645	.531	.530	.500	.569	.486	.459	.432
	Odds		953:1	106:1	389:1	95:1	>9999:1	>9999:1	>9999:1

*The 1920 increase in trunk diameter of the Schmidt was not used in the calculation of Student's Odds because of the winter injury to the trunks of the trees.

**Includes the growth of two seasons, 1917 and 1918.

crops were large. Since 1925 the yield of the trees has been very light because of winter killing of the pistils of the flowers. The crops of 1924 and 1925 were the heaviest borne by the trees up to that time, and it was during these years that the trees made the smallest gains in trunk diameter. These data emphasize the importance of providing good growth conditions during the seasons of heavy crop years.

Bloom and Yield of Fruit

The Schmidt trees were removed before they had attained blooming and bearing age. Records of the blooming of the Montmorency trees were made for five years and the yield of fruit for seven years.

Bloom. The tendency for a tree to bear fruit is better expressed in some instances by the amount of bloom than by the actual fruit produced. In the case of the cherry grown at Morgantown, this was true because of the severe winter killing of the pistils of the flowers. Of course other agencies such as insect pests and diseases may materially affect the set and final yield of fruit. For these reasons the amount of bloom produced by the various trees in each treatment was estimated. It is realized that this method is far from satisfactory, yet a quick method of getting the amount of bloom produced by trees is better than no record at all. Where wide differences exist between trees or treatments the method of estimating has considerable value.

Table 7.—*Influence of various pruning treatments on percentage of Montmorency bloom*

Treatment	Percentage of bloom estimated				
	1921	1922	1923	1924	1925
1. Corrective dormant	58.7	76.8	Practically 100 percent	Practically 100 percent	99.0
2. Moderate dormant	14.2	69.7	Practically 100 percent	Practically 100 percent	94.0
3. Heavy dormant	3.2	51.7	Practically 100 percent	Practically 100 percent	93.0
4. Early summer	17.3	39.6	Practically 100 percent	Practically 100 percent	95.0
5. Moderate dormant and early summer pinching	6.6	74.3	Practically 100 percent	Practically 100 percent	97.0
6. Light dormant and repeated summer pinching	24.2	80.0	Practically 100 percent	Practically 100 percent	95.0
7. Late summer	8.9	64.4	Practically 100 percent	Practically 100 percent	100.0
8. Moderate dormant and late summer pinching	15.0	71.4	Practically 100 percent	Practically 100 percent	100.0

The data for the first five years of bloom of the Montmorency trees are given in Table 7. These data show that the trees produced the first bloom of any importance five years after planting. In the spring of 1921 the correctively pruned trees bloomed by far the heaviest of all the trees under treatment. As the severity of the pruning increased, the amount of bloom decreased. Early or late summer pruning did not increase the amount of bloom produced. Likewise, during the second year of bloom (1922) the correctively or lightly pruned trees (plots 1 and 6) bore more bloom than the trees more severely pruned. The heavy dormant and early summer pruned trees (plots 3 and 4) produced the least bloom of all. In the following years there was practically no difference in the bloom of the trees. It is understood, however, that due to the larger size of the correctively and lightly pruned trees they had a much larger number of blossoms than the heavily or summer pruned trees.

Yield of Fruit. The spring freezes in the years 1921 and 1922 killed all of the blossoms, and no fruit was produced in these years. Beginning with the crop in 1923 the Montmorency cherry trees have borne some fruit every year. The crops of 1924 and 1925 were fairly good but the last four crops were very light due largely to winter injury to the pistils of the flowers. The yields of fruit were measured in quarts and the data for the seven crop years are given in Table 8.

The data of this table show clearly the effects of summer and dormant pruning on the total yield of sour cherry trees. The correctively dormant pruned trees (plot 1) yielded every year more cherries than the trees under any other treatment. The trees that were pruned more severely in the dormant season only (plots 2 and 3) have had the yield reduced by such treatments; in fact as the severity of the dormant pruning was increased the yield of fruit generally decreased. Both early and late summer pruning markedly reduced the yield. It should be pointed out that both early and late summer pruning, of the same severity as the moderate dormant, reduced the yield by about one half as compared to similar dormant-pruned trees. These data show clearly that summer pruning, either early or late, should be discouraged in sour cherry orchards. Likewise, dormant pruning of greater severity than the corrective pruning is not to be recommended because of the dwarfing of the trees and the small yields of fruit that follow.

The data for the average annual yield of cherries as influenced by the various pruning practices (Table 8) have been reduced to a ratio basis. Student's method of calculating odds has been used in an effort to determine their significance. These data, given in Table 9, show that when the yield of the various plots are compared with that of plot 1 (correctively dormant pruned), every pruning practice employed in these investigations has significantly reduced the yield of fruit. It is also shown that the yield of cherry trees was very materially affected by either summer or dormant pruning of greater severity than the corrective pruning.

Winter Killing of Montmorency Cherry Buds

It has already been pointed out that during the last four years of the experiment the crop of fruit was materially reduced by winter injury of the pistils of the cherry buds. The data of Table 8 show how serious this injury has been as the trees have gained in size and fruit-bearing capacity.

Cherry buds in which the pistils have been killed during late winter or early spring open normally and to casual observation would appear to be normal. However, on close inspection it will be found that varying degrees of pistil injury may be present. In some instances only the stigma may be killed; in others the pistil down to the ovule may be entirely dead. Observations and actual counts in

TABLE 8.—*Influence of various pruning treatments on Montmorency cherry yields*

Treatment	Average total yield in quarts per tree							Total yield in quarts
	1923	1924	1925	1926	1927	1928	1929	
1. Corrective dormant	9.73	29.07	40.77	15.10	18.25	23.40	12.15	148.47
2. Moderate dormant	5.43	19.41	27.25	4.65	13.04	21.25	8.87	99.90
3. Heavy dormant	3.11	20.04	17.55	3.02	5.94	13.40	3.17	66.23
4. Early summer	2.48	11.37	16.22	2.16	4.93	15.75	3.45	56.36
5. Moderate dormant and early summer pinching	4.03	12.45	22.56	4.41	7.94	20.83	3.33	75.55
6. Light dormant and repeated summer pinching	5.09	13.68	19.39	4.03	13.44	23.20	5.60	84.43
7. Late summer	2.93	12.01	15.25	1.02	3.00	7.19	5.38	46.78
8. Moderate dormant and late summer pinching	4.03	7.70	15.06	2.56	1.03	21.83	1.42	53.63

TABLE 10.—*The effect of winter injury* (1924-1925) *to the tree trunks and crotches on the hardiness of the pistils of the flowers of Montmorency cherry* (1925-1926)

Row	Tree	Limb	Remarks	Total number of buds	Total number of flowers	Total number of flowers with pistils killed	Average number of flowers per bud	Percentage of flowers with pistils killed
10	3	1	Normal limb. Heavy pruned	302	646	603	2.14	93.34
10	3	2	Limb completely girdled	267	748	37	2.80	4.95
11	1	1	Pruned in early June—normal limb	106	223	209	2.10	93.72
11	4	1	Pruned in early June—normal limb	172	243	242	1.41	99.59
11	7	1	Pruned in early June—trunk winter injured	163	361	266	2.21	73.68
11	15	1	Limb little affected by winter killing	149	315	249	2.11	79.05
11	15	2	Limb partially girdled by winter killing	235	570	129	2.42	22.63
11	15	3	Limb completely girdled by winter killing	214	501	14	2.34	2.79

the orchard have shown that this injury has, in general, been most severe on the summer-pruned trees followed by the heavy dormant pruning. In general, the practices that have stimulated late growth of the trees or those that have removed their leaf area have resulted in more injury to the pistils of the flowers than where the trees were not forced into late growth by pruning or fertilization treatments or where a maximum leaf area was maintained until late fall.

TABLE 9.—*Influence of pruning treatments on the average total yield of Montmorency cherry trees*

Year	Average yield of cherries*							
	Pruning treatment numbers							
	1	2	3	4	5	6	7	8
1923	1.0	.56	.32	.25	.41	.52	.30	.41
1924	1.0	.67	.69	.39	.43	.47	.41	.26
1925	1.0	.67	.43	.40	.55	.48	.37	.37
1926	1.0	.31	.20	.14	.29	.27	.07	.17
1927	1.0	.71	.33	.27	.44	.74	.16	.06
1928	1.0	.91	.57	.67	.89	.99	.31	.93
1929	1.0	.73	.26	.28	.27	.46	.44	.12
Average	1.0	.651	.400	.343	.469	.561	.294	.331
Odds		810:1	>9999:1	>9999:1	3332:1	755:1	>9999:1	2249:1

*In this table the average annual yield of cherries in quarts per tree produced on the trees of treatment 1 (corrective dormant) has been taken as unity, and the yield of the trees of the other treatments has been compared with it.

There was opportunity in the spring of 1926 to make extended observations on the winter killing of the pistils of Montmorency cherry flowers. The winter of 1924-1925 caused severe injury to tree trunks and crotches of this variety. As a result some trees and particularly some branches of the trees responded in growth and fruit-bud formation as though they had been girdled. At blossoming time in the spring of 1926 counts were made of the number of flower buds formed and the number with pistils killed on normal, partially, and completely girdled limbs from the same and from different trees.

These results, given in Table 10, show that the limbs partially or completely girdled formed the most flower buds per fruit bud. Girdling greatly increased the hardiness of the pistils. The limbs that had been completely girdled by the winter injury had the fewest pistils killed while the trees or limbs which were in the most thrifty and vigorous condition suffered the most injury.

The writer has observed that under West Virginia conditions the pistils of cherry flowers (Montmorency) are often killed by low temperatures in late winter, and that the severity of the injury has been in relation to the vigor or growth of the tree. Sour cherry trees that have been severely pruned or heavily fertilized have been found to bear fruit buds more susceptible to pistil injury than similar trees not stimulated by such practices. This injury probably is due to a difference in the rate of growth and development of the buds during the winter and up to the time the killing temperatures occur. The trees that were stimulated into unusual growth by pruning or fertilization probably have a narrower carbohydrate-nitrogen ratio and a shorter, less profound rest. As a result they make more growth during the warm periods of the winter than trees in which the carbohydrate-nitrogen ratio is wider. This view is supported by the work of Crane *(2)* with the peach and by the fact that the buds on the girdled cherry limbs bloomed several days later than those of the pruned trees.

DISCUSSION

It is unfortunate that the sweet cherries were so severely winter injured that they had to be removed before attaining fruiting age. However, the data for the growth of the Schmidt trees included in this report agree so closely with that of the Montmorency, and the data for the growth and yield of the latter variety are so significant, that it would seem that the effects of certain pruning practices with cherries are clearly defined. This is especially true when it is considered that the results of this experiment substantiate those obtained by Chandler *(1)*, Tukey *(10)*, Rogers *(8)*, and Shoemaker *(9)*.

Chandler *(1)* as a result of his experiments in pruning various fruits says in regard to pruning sweet cherries, "It was clear that to prune a sweet-cherry tree to any form different from that to which it would naturally grow is more of a dwarfing process than with any other fruit tree under experiment. It must delay fruiting proportionately." In his experiments with sour cherries he found that the early pruning necessary to form open-headed trees dwarfed them and reduced the yield as compared to trees allowed to grow normally. In summarizing his results he was of the opinion that cherry trees should receive very little pruning until they were eight or nine years old. The data presented in this report of the West Virginia experiments substantiate this opinion.

Tukey *(10)* working with old Montmorency, English Morello, and Early Richmond trees which had grown tall, attempted to lower the tops by pruning and to increase the vigor of the trees by nitrate of soda applications. The pruning checked the total tree growth the first season and at the end of three years the growth of the pruned trees did not equal that of the unpruned ones. However, where nitrogen was also applied, the pruned tree at the end of the third season had recovered and appeared more vigorous than untreated trees. The yield of fruit on the pruned trees was much less in the first season following the pruning and failed to equal the yield of the untreated trees at the end of the third season. However, when the trees were fertilized in addition to the pruning, by the third season the yield was equal to or greater than that of the untreated trees. He presents data to show that pruning increases the size of the cherries.

Rogers *(8)* in a report on a sour cherry orchard says of trees which had been rather severely pruned, "During their non-bearing period. . . . their bearing was delayed and their early crops materially and unnecessarily reduced." The records show that the severely pruned trees were from three to five years behind lightly pruned trees in fruit production.

Shoemaker *(9)* in reporting on cherry pruning experiments in Ohio with trees planted in 1914, some of which were very lightly pruned and others heavily pruned, presents data that show the yield of the lightly pruned trees for the five crop years of 1923 to 1927, inclusive, to be greater than that of the heavily pruned trees. He says, "The very light pruning, however, led in course of time to very thick, bushy conditions, and the fruit ripened unevenly, so that several pickings were required in 1926 and 1927."

From the data presented in this report and from the experimental evidence of other workers cited above, it seems clear that cherry trees during the vegetative or non-bearing period should receive only sufficient pruning to train the trees to a modified central leader tree. The debudding method of starting the young trees as recommended by Fagan *(3)* and by Fagan and Anthony *(4)* has proved so successful with apples that it would seem that a modification of this method could be advantageously used in starting young cherry orchards and thus eliminate to a large extent the pruning necessary to shape the tree.

The correctively pruned trees in this experiment have been pruned lightly each year, and although the trees are somewhat bushy and thick, no appreciable differences have been observed in the time of ripening of the fruit on these trees as compared to those on the more severely pruned ones. This, of course, may have been due to the very light crops produced during the last four years. As the trees become older more severe pruning may be necessary to keep the trees open. Roberts *(6)* found the open-head tree to be desirable in order to increase the number of spurs that remain alive. He also found that the spur fruit buds are less susceptible to winter injury than those on terminals, which is in accord with the observations made in West Virginia. He gives evidence in favor of renewal-pruning for old cherry trees, as this not only results in the production of more buds on spurs but also increases the growth and vigor of the twigs. Roberts *(7)* in a later report gives some data which indicate that such pruning may increase the yield of fruit on older trees.

The data presented in this report show clearly the severe dwarfing effect of summer and heavier than corrective dormant pruning on the tree growth of sour cherry trees. Yield was also greatly reduced. The data likewise show that summer pruning, either early or late, decreased yield as compared to trees pruned with equal severity in the dormant season. This reduction in tree growth and yield of fruit following summer pruning apparently is due to the removal of the leaves before they have made their contribution to the food supply of the tree. This would emphasize the great importance of maintaining during the summer and early fall the maximum area of leaves capable of functioning photosynthetically.

Tukey *(10)* points out that severe pruning practices increased the size of the cherries, but Rogers *(8)* says that exceptionally large, sour cherries are not particularly wanted by the canners. In the West Virginia experiments the fruits borne on the correctively pruned trees, as far as observed, were very slightly, if at all, smaller than those produced on the more severely pruned trees. This may have been due to the small crops of fruit borne during the last four years of the experiment.

CONCLUSIONS

Young correctively pruned sour cherry trees make more shoot growth and larger gains in trunk diameter, come into bearing earlier, and produce heavier crops than similar trees more severely pruned. Summer pruning, regardless of the time during the summer when it is done, has the effect of severely dwarfing tree growth and reducing the yield, as compared to dormant pruned trees which had been pruned equally as severely.

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